CARBON DIOXIDE CAPTURE FROM AGRICULTURAL BIOMASS: AN OVERVIEW ON THE ASSESSMENT METHODS [1]

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ABSTRACT
Climate change concerns have increased over recent years and the issue linked to carbon reduction is a worldwide global challenge, thus representing the objective of several scientists, producers, policy makers as well as consumers. A large strand of recent literature has shown the role of crops in preventing carbon dioxide emission as a consequent immobilization by vegetable biomass. In this direction the methods to assessthe linkage between carbon dioxide capture and crops production all over the agricultural supply chain have experienced several applications. In order to better contextualize the existing lines of research about the analysis of CO_2 capturedby crops and biomass plantation, this paper analyzes the most relevant scientific contribute on different estimation methods used in such studies. In particular this paper presents an overview of the main analytical approaches adopted in analysing the role of agricultural activities in reducing carbon emissions that have been developed so far in terms of economic, social and environmental perspectives.

KEYWORDS
carbon emission reduction, agricultural sustainability, sustainable cultivation, bioenergy crops, estimation methods.

INTRODUCTION

Bioenergy is a renewable form of potential alternative to traditional fossil fuels that came to the fore as a result of the recent concerns about the high price of fuels, national security, and climate change.The climate change concerns have increased over recent years (Lal, 2004; Gibbins et al., 2008) and the issues linked to carbon reduction emission is of increased interest to producers, policy makers and consumers (Metz et al., 2005; Lal et al.,1998; Frumhoff et al., 2015; Bentivoglio et al., 2014; Di Vita, 2016; Bentivoglio et al., 2016). The most recent researches have shown the role of agricultural practices in preventing carbon dioxide emissionand the consequent immobilization in the biomass of plants is physically possible and in this direction is therefore of fundamental importance the action of the plants in the capture of CO2 and greenhouse gas reduction (Don et al., 2012). In this context, considerable importance is the action of biomass for two environmental functions: 1) to provide alternative energy to traditional fossil sources and 2) to contribute through increased coverage of agricultural land to a greater carbon sequestration fees and other greenhouse gases.A number of models exist that attempt to explain the link between carbon dioxide capture in the agricultural supply chain both for crops and biomass production plants and the methods to assess it have experienced several application.

This paper presents themain methodologies and analytical approaches adopted in analysing the role of agricultural activities in reducing carbon emissionsby crops and biomass plantation that have been developed so far in terms of economic, social and environmental perspective at national and international level.

1. METHODOLOGY

This research was conducted through an analysis of the studies published in academic journals, in particular, we have considered the main databases relating to the following sources; ISI Web of Science, Scopus, Google scholar, Research gate, Blackwell Synergy, CAB Abstracts, Oxford Journals, Elsevier, Springer and Wiley Interscience. In all databases, a hierarchical search procedure was implemented. The typed words were: bioenergy crops, CO2 capture, agricultural sustainability, CO2 models management, agricultural greenhouse emission. This procedure has led us to about over 800 results (including those present in different databases). For all these, they were extracted and consulted only those strictly related to the hypothesis of the present research work. This resulted in the identification and analysis of 56 works of potential relevance to the present work.

2. RESULTS

The following section is a review on the main contributions in terms of methods used to evaluate the interaction between use of land under crops, biomass plantation and carbon reduction.

Cost-benefit analysis

The benefits of reducing carbon emissions have been extensively debated. Since 1990 a study on the carbon dioxide emission limits has made cost-benefit analysis of the reduction of $C0_2$ emissions, considering the different interactions between the economy and energy in order to determine the economic cost of carbon emissions.In particular, this study - analysing three question parameters (potential GDP growth, the elasticity of price substitution induced between capital-labour and energy and the energy efficiency

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improvement rate), which are crucial to the debate on energy and the future of the environment –it has analysed the impact of different energy sources including those that are currently in use and those that could be used, through cost-benefit analysis (Manne and Richels, 1990).

In an another study based on the costs and benefits analysis,the amount of carbon sequestered through reforestation on a large scale was evaluated, assuming that forests were managed in perpetual rotation. Based on the available land for afforestation, they have been identified 20 case studies in five regions in China. The least expensive way to develop forests in order to sequester carbon emissions is the case of *Pinusmassoniana* from the start point of view of investments, and then *Fir*. The cases of open forest management are less expensive options because of their low investment rotation, even if their annual increases in wood are low. Some of less productive trees have higher net costs for carbon sequestration. For the majority the net costs of agroforestry systems are low, especially in the South, South-West, and the North of China, even if their initial investments are high (Xu, 1995).

Recent studies on cost benefits have also highlighted the prospect resulting from integrated multi-functional biomass production systems, managed to provide specific environmental services, as well as a production of biomass for feeding. This study showedthat the environmental benefits of large-scale multi-functional biomass production systems could be substantial. The presence of additional revenues generated by biomass production systems could improve the socio-economic attractiveness and significantly improve the competitiveness of biomass produced on the market. The provision of additional environmental services also contributes to the local sustainable development, which is in many cases a prerequisite for local support for systems of production (Berndes et al., 2008)

WTA -Willingness To Accept by the crop producers: some statistical models

Using data from a survey conducted among some agricultural producers, it was applied a utility model using a discrete choice to determine the probability of participation of the owners to the carbon crops cultivation tackers and their average about theirWillingness To Accept (WTA) related to possible compensation arising from the implementation of a reforestation program. The WTA, included an estimate of the positive and negative benefits for producers resulting from the carbon-fixing trees plantation, and an analysis of the costs arising from the loss of income resulting from the main agricultural activity (van Kooten, 2000).The estimated results through the WTA are less than the lost revenue, and also the average cost of carbon creating credits still exceed their value provided as part of a CO2 emissions trading scheme (van Kooten, 2000).

Equally interesting is the application of a statistical model on declared preferences (stated preference). This model has been implemented in order to detect and measure in which it was asked to choose between different contract terms in the case of starting the cultivation of biomass. The results show that participation is mainly influenced by a guaranteed minimum price, length of contract, and the possibility of re-negotiation before the end of the contract (Harpsichord et al., 2014).

An interesting review wasalso developed about the public perception and the acceptance of Carbon Capture and Storage (CCS) (Selma et al., 2014). This study highlights the high importance of the factors and social aspects related to the acceptance of carbon capture (Selma et al., 2014)

Several methodological approaches were used to know the willingness to cooperate with populations in Carbon Capture and Storage (CCS). A recent study examined the agricultural producers to convert their production to more efficient crops in carbon dioxide capture. Recent research has looked at the various factors that may induce producers to convert their crops conducted in marginal areas into plantations increased carbon absorption, assessing the economic effects, environmental, social, and potential carbon sequestration costs through afforestation in western Canada (Shaikh et al., 2007).Later studies have also shown that private forests not addressedto industrial production (NIPF) often tend to have large quantities of small diameter trees. The use of biomass residues and small-diameter trees cannot be marketed may be used for bioenergy production by creating economic opportunities favorable for NIPF landowners. By estimating the willingness of producers to provide woody biomass for bioenergy, this approach has been demonstrated that the availability of land owners is affected appreciably by the size of the forest, the structure and composition of tree species and by demographic characteristics (Joshi and Mehmood, 2011).

Consumers also have been the subject of study on their level of acceptance on the various carbon capture and storage methods. Through conjoint analysis on the levels of acceptance and variance analysis CCS were examined the preferences of some Swiss citizens towards different forms of capture and storage of carbon dioxide (CCS).Although this study has shown a certain mistrust of the capture and storage facilities located near their homes, the effect not in my backyard (NIMBY) disappears in the presence of combustible biogas plant used for injection (Wallquist et al., 2012)

MRA - Meta Regression Analysis

Parallel studies on the determination of carbon offsetting have been conducted through a meta-analysis of the costs related to the amount of carbon dioxide captured, taking into consideration the different types of processing of the agricultural land (Manley et al., 2005).

The Meta-Regression Analysis (MRA) is a systematic process to analyze data from a variety of studies on a given phenomenon to find out the factors that influence it. Regression analysis is used to identify the links between the characteristics of a study, and the results, so that the overall trends in the data can be recognized and used as indicators to make predictions on the expected results under a variety of previously identified circumstances.

Although individual studies provide estimates of the relationship between variables in a given point in a limited set of circumstances, the MRA allows a connection between the results of individual studies for a more general description of the relationship between variables (Curtis and Wang, 1998). An interesting work of meta-analysis was conducted by setting up the codification of different indicators through the development of analysis descriptive statistics using the mean, standard deviation, etc. (Curtis and Wang, 1998).The results obtained in an another empirical study, based on regressions allowed to calculate the carbon absorption costs in agriculture for different locations and types of crops (Manley et al., 2005). In particular, the economic costs of some crops in the presence of an intensive or conventional processing were estimated (CT) with respect to a minimum processing, highlighting the amount of storable carbon (Manley et al., 2005).

Life Cycle Assessment (LCA)

LCA is a particularly indicated approach for assessing the carbon dioxide emissions and is a tool widely used in the current research in-depth on these issues (Pergola et al., 2013).The LCA has been adopted to detect several environmental benefits in the use of biomass in terms of reducing greenhouse gas emissions and save natural resources (Carpentieri et al., 2005).

LCA evaluates the set of interactions that a product or a service has with the environment, considering its entire life cycle starting from pre-production phases (extraction and production of materials), manufacturing, distribution, use (so also reuse and maintenance), recycling and final disposal. The LCA procedure is standardized internationally by the ISO 14040 and 14044 standards. The LCA aims are to establish a complete picture of the interactions with the environment of a product or service, helping to understand the environmental consequences directly or indirectly caused in order to share with decision makers the information needed to define the behaviours and the environmental effects of activities and identify opportunities for improvement, in order to achieve the best solutions for tackling the environmental conditions (Edwards-Jones et al., 2009).

In a study conducted by Swiss Federal agencies (BFE, BLW and BAFU) it has been taken into account the data related to the life cycle of some energy products from biomass. Starting from the analysis of certain types of biomass and of their energy products such as, for example, agricultural products (Nemecek et al. 2007), renewable materials (Althaus et al. 2007b) or wood products (Werner et al., 2007), as well as their use in combustion processes (Althaus et al. 2007a), this study provided a systematic overview of the different types of bio-energy that are of general interest, by distinguishing the four stages of production: supply of biomass, converting a combustible, distribution and use (Frischknecht et al. 2007).

Later studies allow to detect how LCA methodology application has shown a negligible environmental impact resulting from the planting and explanting of new crops intended tobiomass production, in particular this study confirms the superiority arising from the use of renewable resources (such as biomass) compared to coal consumption, in terms of depletion of natural resources and reduction of greenhouse gas emissions (Carpentieri et al., 2005).

Another interesting method that can be indirectly be ascribed to LCA analysis is GREET model: that allows the lifecycle analysis of GHG emissions. An important experiment was carried out through this methodological approach by Searchinger et al., (2008). The authors have compared the emissions of biofuel produced from corn, and those arising from the use of gasoline, finding that biofuels made from corn crop increases of about 50% of greenhouse gas emissions, mainly including those of carbon dioxide. However, it should also be stressed how discordant results were achieved through the debts carbon method, in this case other authors have shown that biofuels are a potential source of low-carbon energy, but if biofuels offer carbon savings that it depends on how they are produced (Fargione et al., 2008).

Recently LCA was provided with a new an index which can be promptly included in the analysis (Cherubini et al., 2011). This method allow to estimate the climate impact of CO_2 emissions from biomass combustion. This method uses the impulse response functions of CO_2 (IRF) in the development of decay functions of atmospheric CO2 emissions from biomass burning. The contribution to global warming is then quantified by an index based on units, the GWP bio. Since this index is expressed as a function of the period of rotation of the biomass, this index can be applied to the CO_2 emissions from the combustion of all the different species that constitute biomass, from annual crops to the most slow growing crops such as forestry crops (Cherubini et al., 2011).

Additional importance acquires another indicator used to accurately estimate the greenhouse gas emissions by measuring the change in soil organic matter and carbon (soil organic carbon) (SOC) (Liebig et al., 2008). The variation of the SOC index must be considered at the time of the LCA. In fact, greenhouse gas emissions from bioenergy crops vary in space and time. Such variation implies the need for long-term environmental monitoring sites in major agro-ecoregions (Liebig et al., 2008).

Carbon Footprint

In addressing issues related to climate change have been used various parameters among these has assumed major importance estimation of the total amount of greenhouse gases (GHG) emitted during production, processing, retail and use many consumer goods, including food (Rădulescu et al., 2014; Nonhebel, 2006).Among these it has progressively assumed major importance the Carbon Footprint. It shows the emission of gases responsible for climate changes such as CO_2, methane (CH_4), nitrous oxide (N2O), tetrahydrofluoro carbons (HFCs),Perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6) etc., issued following the production of a product, or otherwise attributable to activities performed by an organization or a simple individual.

This parameter measures the environmental impact that anthropogenic emissions have on climate change. The carbon footprint of a product is expressed in terms of Global Warming Potential (GWP) and is expressed in terms of kg of CO_2 or CO_2 equivalent. The IPCC (2007) suggests that the impact of 1 kg of methane on global warming is equivalent to that of 25 kg of carbon dioxide, while 1 kg of nitric oxide is equivalent to 298 kg of carbon dioxide. This parameter has been widely used in numerous studies aimed at measuring the total amount of greenhouse gases produced for certain activities related to the extraction/production of raw materials, production, use and end of life of the product (Carbon Trust, 2007; Edwards-Jones et al., 2009).

However, it is not unusual to note that in literature the carbon footprint estimates differ widely, although they refer to the same product, and similar production processes. In this sense, some studies have tried to address these distortions. One of these evaluated the uncertainty of estimates based on carbon footprint, through analysing the statistical analysis on the results of an extensive collection of studies. The results show high variability in estimates carried through empirical studies and how these estimates depend heavily on specific characteristics of the study such as the methodologyadopted to overcome these differences can be useful to the application of meta-analysis to specific products (Caracciolo et al., 2012; Cembalo et al., 2013).

Recent research has highlighted the important role that coastal and marine ecosystems play in the sequestration of Carbon Dioxide (CO2). Although their global extension is one to two orders of magnitude less than that of terrestrial forests, the contribution of coastal habitats vegetated to long-term sequestration of carbon per unit area C is much greater, in part because of their efficiency in the organic carbon capture and associated suspension during floods and tides. Despite the value of mangrove forests, seagrass beds, and salt marshes in the sequester C, the recognition of C sequestration by the vegetation of coastal ecosystems constitute valid grounds for their protection and restoration; However, it is necessary to improve the scientific understanding of the underlying mechanisms that control C sequestration in these ecosystems (McLeod et al. 2011)

Multi-criteria analysis

Also (MCDA) has been used in recent studies, to develop and integrate different attribute linked to morphological and territorial characteristics with biomass energy crops. The MCDA has become increasingly popular in the decision-making process for sustainable energy because of the multidimensionality of sustainability and the complexity of the socio-economic and biophysical systems (Wang et al., 2009; Romano et al., 2013).

Using environmental data on climate land use, soil, Lupia et al., (2007) identified the suitability of sunflower through the definition of criteria and constraints in a GIS environment. By obtaining a map of land suitability authors identified the territorial vocation,considering the spatial heterogeneity (Lupia et al., 2007).

Additional multi-criteria analyses were conducted with reference to the reactions of interested parties (stakeholders) the possibility to capture CO_2 mitigation in five different energy scenarios involving a number of different levels of capture and CO_2 storage (CCS). The results suggest that there is unlikely to be a broad consensus among stakeholders on the desirability about specific future forms of energy power generation. In the end, the results support the inclusion of CCS within scenarios of a low-carbon energy system (Shackley and McLachlan, 2006).

Utility function

A recent contribution on the main methods used in bioenergy studies is provided by Lundgren and Marklund (2013) which found that most of the analysis have used or implemented partial models that do not take into account all the relevant aspects, and do not include in full all the variables that affect the economic and ecological system, which can lead to false conclusions, especially, with regards to environmental policy decisions concerning the support to the growth in the use of biomass for the production of bio-energy. Most of these do not explicitly consider the environmental and / or climatic externalities, do not provide complete studies for a comprehensive analysis of the collective well-being. These effects are certainly relevant when, for example, considering the costs and benefits of bioenergy as an alternative to fossil fuels. In fact, to assess the externalities, we must adopt an approach that includes not only economic indicators, but also requires the variables related to the environment and to the climate reference (Lundgren and Marklund, 2013; De Luca et al., 2015). In this regard, some authors have proposed the use of a model based on the utility function, which is based on the production functions, and capital, and natural artificial stockpiles, including the environment (Lundgren and Marklund, 2013). The relevant consumer receives a benefit from the consumption and related environmental factors. The utility values expressed by consumers depend on their preferences and are represented through a specific mathematical function (utility). This model assumes that the preferences and utility function can be expressed as U (C, E, G) where: C is the consumption of goods and services, and E is a stock environment not directly linked to carbon emissions, G is the concentration of carbon in the atmosphere (Lundgren and Marklund, 2013).

Further studies have taken into account the calculation of Net Primary Production (NPP), and the removal of carbon through the production. In a survey of fruit orchards and vineyards of southern Europe, through the eddy covariance net primary production was estimated (NPP) and the subsequent removal of carbon through the production, as well as the potential carbon sequestration for the vineyards and the main fruit tree species (apple, citrus fruits, olives, and fishing) grown in Italy (Scandellari et al., 2016). The results had shown that in the presence of ripe fruit the ecosystem recorded a positive net productivity (Scandellari et al., 2016)

Further analysis confirmed the benefits of Eddy covariance, which ensures the CO_2 growth rate across the interface between the atmosphere and the crops by measuring the covariance between the vertical wind velocity fluctuations and CO_2 ratio mix. Two decades ago, the method has been used to study the CO_2 exchange of agricultural crops in ideal conditions. Over the past decade the eddy covariance method has emerged as an important tool to evaluate the carbon dioxide flows between terrestrial ecosystems and the atmosphere. Currently, the method is applied almost continuously to study the exchange with carbon dioxide and water vapor (Baldocchi, 2003). This method is non-intrusive, allows direct measurements of evapotranspiration and NEE (Net Ecosystem CO_2 Exchange), it can be used to sample large areas if homogeneous. In addition, long-term measures are possible and can measure different chemical species and the flow of energy (Curtis et al., 2002; Baldocchi, 2003).

Qualitative approach

Other studies, using qualitative research methods, have taken into account the social aspects as well as environmental-related interest by stakeholders on the possibility to convert forest biomass into energy. These methods have allowed the identification of functional issues to the conversion of CO2.

The first study conducted in the USA through semi-structured interviews with various interest groups, explored the social context as a prelude to the conversion of forest biomass for energy. It evaluated the technical feasibility of energy forest biomass, focusing on the social aspects (Stidham and Simon-Brown, 2011).The information obtained through interviews have been used to understand the views of interested parties on energy forest biomass, including possible obstacles. The results, obtained through simple descriptive statistics techniques, by comparing average rating between different statements of respondents, and additionally, calculating frequency analysis, allowed to detect pointsof agreement and potential conflicts among various stakeholders such as the need for interventions of restoration in some types of wood and the utilization of by-products for the production of biomass, confirming that qualitative methods constitute a basis for discussion and reasoning for the development of actions for improvement of potentially viable forests and energy with forest biomass (Stidham and Simon-Brown, 2011).

Another qualitative study, based on descriptive statistics, was conducted on a sample of public managers in China (Qu et al., 2012). The results revealed the high importance for renewable energies but a less potential for forest bioenergy as the development of forest bioenergy requires more cooperation between government and enterprises considered its forest functions and its impact on ecosystem (Qu et al., 2012).

Among the qualitative methods surveyed, we alsoobserved the use of SWOT (Strength, Weakness, Opportunities and Threats) analysis connected with the Analytic Hierarchy Process (AHP) to commonly used decision analysis methods. The connection of AHP with SWOT allows to obtain analytically a certain priority for the factors included in the SWOT analysis and makes them commensurable. The goal in applying the hybrid method is to improve the quantitative database in strategic planning processes (Kurttila et al., 2000; Dwivedi and Alavalapati, 2009).One study in particular examines the perceptions of four groups of stakeholders (non-governmental organizations - NGOs, the government, industry and academia) with regard to forest biomass-based on bio-energy development in the Southern United States through the combination of SWOT with the AHP. The results suggest that NGO representatives perceive rural development as an important opportunity. The stakeholder group belonging to the government noted that less or no competition with food production and promoting energy security were the main resistance factors. In general, all parties concerned were in favor of forest biomass as the basis for bioenergy development in the Southern United States (Dwivedi and Alavalapati, 2009).These qualitative methodologies allow to improve the quantitative database in strategic planning processes (Kurttila et al., 2000).

DISCUSSION AND CONCLUSION

The prospects for biomass energy production with CO_2 capture and storage might be improved in the future if economies of scale in energy production and/or CO_2 capture and storage will be realised (Metz et al., 2005;Cembalo et al., 2016; Sauvée and Viaggi, 2016). The reduction of carbon emissions is a worldwide global challenge and it represents the objective of many scientists that are trying to modify the role of carbon, turning a problem into an opportunity (DI Vita, 2016). This means that the need for a sustainable agriculture and agro-food products has become a priority for many technologically advanced countries. With this regard, the present study, highlights the current research areas about the most currentestimation methods and analytical approaches used to evaluate the capture of CO_2 by vegetable biomass and crops as well the interest by stakeholders on the possibility to convert CO_2 into biomass.

The rational of the study, as illustrated, was to collect and review the most relevant scientific papers including articles published in international journals, books, working papers, monographs, etc.

In light of this, the main aim was to review the main contributions in terms of methods used to evaluate the interaction between use of land under crops, biomass plantation and carbon reduction, in terms of future prospects and challenges. Firstly, as previously discussed, the benefits of reducing carbon emissionshave been extensively debated. Since 1990 a study on the carbon dioxide emission limits has made cost-benefit analysis of the reduction of $C0_2$ emissions, considering the different interactions between the economy and energy in order to determine the economic cost of carbon emissions. Recent studies on cost benefits have also highlighted the prospect resulting from integrated multi-functional biomass production systems, managed to provide specific environmental services, as well as a production of biomass for feeding.

Therefore, wealso pointed out the application of some statistical models such using data collected among agricultural producers, it was applied a utility model using a discrete choice to determine the probability of participation of the owners to the carbon crops cultivation tackers and their average related to their Willingness To Accept (WTA) about possible compensation arising from the implementation of a reforestation program. The WTA, included an estimate of the positive and negative benefits for producers resulting from the carbon-fixing trees plantation and an analysis of the costs arising from the loss of income resulting from the main agricultural activity (van Kooten, 2000). Moreover, results demonstrated that several methodological approaches were used to know the availability of society and consumers towards carbon capture and storage models (CCS).

While as pointed out, the regression analysis is used to identify the links between the characteristics of a study and the results, so that the overall trends in the data can be recognized and used as indicators to make predictions on the expected results under a variety of previously identified variables (circumstances).Moreover, the Life Cycle Assessment is used to establish a complete picture of the interactions with the environment of a product or service, helping to understand the environmental consequences directly or indirectly caused providing useful information to decision-makers. This method allow to estimate the climate impact of CO2 emissions from biomass combustion.

Also the MCDA has become increasingly popular in the decision-making process for sustainable energy which has been used in recent studies, to develop and integrate different attribute linked to morphological and territorial characteristics with biomass energy crops.

Secondly, recent contributions had put forward the use of the model based on the utility function, which is on the production functions, and capital, and natural artificial stockpiles, including the environment (Lundgren and Marklund, 2013). In particular, it considers the environmental and/or climatic externalities in order to provide a comprehensive analysis of the collective well-being. These effects are certainly relevant when, for example, considering the costs and benefits of bioenergy as an alternative to fossil fuels. Thirdly, results showed that other studies using qualitativeresearch methods, such as studies based on semi-structured interviews with interest groups; based on descriptive statistics; SWOT analysis connected with the Analytic Hierarchy Process (AHP) and commonly decision analysis method, taking into account the social aspects as well as environmental-related interest by stakeholders on the possibility to convert forest biomass into energy. These methods have allowed the identification of functional issues to the conversion of CO_2.

On the basis of what previously highlighted and according to recent studies from the use of bio-energy crops they should be able to provide a significant contribution to climate change mitigation. However, as discussed, bioenergy is not necessarily a “carbon neutral” because emissions of CO_2, N_2O and CH_4 during the production cycle of the crops, such emissions can reduce or eliminate almost completely the use of containment resulting CO_2 of replaced fossil fuels. These Green House Gases (GHG) must be included in calculating the carbon footprint of different bioenergy crops taking into account the soil conditions and the agronomic management practices.

In the interim, the growing interest in trade in biofuels between developed and developing countries has stimulated thorough debate around the world focusing its attention on issues such as the economic outlook for rural populations, subsidies and food for fuel crisis (Bellia et al., 2016; Pilato et al., 2016).

Finally, even the EU's agricultural policies have highlighted dynamics times in decreased carbon footprint and also recognize the possibility of a reduction in profit margins by farmers, supporting the productive and economic efforts (Caracciolo et al., 2012).Therefore, in evaluating the introduction of new agricultural and forest policy measures should be carefully assessed the positive and negative effects that such measures exert on the environment as a whole. Nevertheless, in taking into account all costs and economic and social environmental benefits, it is necessary to consider the assessment of collective welfare effects, parallel estimating the economic benefits in terms of promoting economic growth per se (production of biomass for bioenergy, supply raw materials, production of forestry products, increase employment, defense of the territory, etc.), always keeping out the environmental and ecological characteristics of the reality in which a new project starts or a new policy applies agricultural and forestry measures (Lundgren and Marklund, 2013).

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